STATEMENT

OF

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to the

SUBCOMMITTEE ON DOMESTIC AND INTERNATIONAL

SCIENTIFIC PLANNING AND ANALYSIS

of the

COMMITTEE ON SCIENCE AND TECHNOLOGY

UNITED STATES HOUSE OF REPRESENTATIVES

on the

US-USSR PROGRAM IN CHEMICAL CATALYSIS

Thursday, 20 November 1975

Mr. Chairman and members of the Subcommittee:

My name is John D. Baldeschwieler. I am Chairman of the Division of Chemistry and Chemical Engineering of the California Institute of Technology, and Working Group Chairman of the US-USSR Program in Chemical Catalysis. I am delighted to appear before you to describe past progress and future prospects for the Joint US-USSR Program in Chemical Catalysis.

Background

A science and technology agreement with the Soviet Union was signed by President Nixon on 24 May 1972. To carry out the terms of the agreement, the two countries have established a Joint Commission on Scientific and Technical Cooperation. The US-USSR Program in Chemical Catalysis was approved for priority implementation by the Joint Commission on 21 March 1973, and I was asked by Dr. Stever to serve as Chairman of the US Working Group. The Chairman of the corresponding Soviet working group is Dr. G. K. Boreskov, Director, Institute of Catalysis, Novosibirsk, USSR.

The program in catalysis is organized into five projects, each headed jointly by a US and Soviet Project Coordinator. The research activity supported by the program is carried out by US postdoctoral fellows working in Soviet laboratories, and vice versa for periods of three months to one year. The project titles, project coordinators, and principal investigators currently involved in the program are listed in Table I. The US component of the program is supported by research grants awarded to US investigators by the National Science Foundation. These grants are administered in the Chemistry Division of the NSF by Dr. Oren F. Williams.

The American Chemical Society provides assistance in the administration of the catalysis program. This activity is also funded by a National Science Foundation grant administered by Dr. John R. Thomas in the Office of International Programs. Dr. Richard L. Kenyon d 1976 is the Program Administrator for the American Chemical Society. The ACS staff which includes Mrs. Maria A. Snow, Assistant Program Administrator, in addition to Dr. Kenyon, is in direct contact with the State Department, the US Embassy in Moscow, and with various Soviet organizations including the USSR Academy of Sciences,

and the Soviet Embassy in Washington regarding travel arrangements for both US and Soviet principal investigators and postdoctoral fellows.

Program Substance

A catalyst is a material which promotes a chemical reaction without itself participating in the reaction. Catalysis technology is at the heart of the chemical and petroleum process industries. Improvements in catalyst designs have yielded improved efficiency and reduced energy requirements, and thereby reduced costs for an enormous volume of products produced and marketed in the US and abroad. The US research effort in chemical catalysis has been carried out both in university and industrial laboratories. University laboratories have contributed to the basic understanding of the mechanism of chemical catalysts, while the effort in industrial laboratories has included the development and exploitation of practical catalysts for industrial processes. Basic research carried out in university laboratories generally has been available in the open literature, while the industrial catalyst technology which is at the heart of the chemical process industry, is highly proprietary and has been very closely held.

The Soviet Union also has a long tradition of research in catalysis, with an overall level of effort which probably exceeds that in the United States. Soviet contributions to basic research generally have been of good quality. On the other hand, they have had difficulty moving developments from basic research into industrial applications, and their industries generally have lagged in catalyst technology.

The choice of specific projects under the catalysis program was determined by the principle of maintaining an approximate quid quo pro in the

exchange of information between US and Soviet groups, and the decision to focus the program on fundamental research issues. For example, in Project I, Catalysis by Coordination Complexes and Organometallic Compounds, the Soviet work on the synthesis of organometallic complexes for nitrogen fixation has been excellent, and we have already benefited from their expertise. On the other hand, the physical methods and understanding of reaction mechanisms are superior in the US. The second project, Catalytic Reactor Modeling, involves the use of mathematical methods and computers to predict the behavior of large catalytic reactors. In this area, the Soviet mathematical analytical methods are excellent, whereas US computational techniques are more advanced. Project III, an In-depth Study of Selected Catalytic Systems, involves an attempt to standardize physical methods for characterizing catalysts. In this area, Soviet traditional physical chemical and kinetic methods have been excellent, whereas instrumental methods in the US are more advanced. In Project IV, the Study of Life-support Systems for Possible Use in Space Travel, both the US and the USSR are seeking more efficient methods for the optimum conversion of metabolites to products that would continue to be useful in long-term space travel. In Project V, entitled Environmental Control, both the US and the USSR have agreed to a joint approach to the problem of finding catalysts which will aid in the decomposition of nitric oxide. Although there are several methods for the reduction of nitric oxide which are in advanced development for reducing the level of oxides of nitrogen in automotive exhausts, the direct catalytic decomposition of nitric oxide has not yet been achieved. A fundamental advance in this area would be of obvious interest to both countries.

Progress to Date

The number of US research fellows who have completed their work or who are currently in the Soviet Union, and the number of Soviet fellows who are now in the US, or who have completed their work in this country, are summarized by project in Table II. Research publications resulting from work carried out under the program are given in Table III. We have been able to find ways of working productively with the Soviets, and the published research indicates some of the first results from the Joint Program.

Problem Areas

Working with the Soviets in the Joint Program has been a difficult and tedious process. A particular difficulty has been establishing timely and reliable communications with the Soviet scientists working in this program. Through considerable experimentation, we have succeeded in finding methods to resolve most of the aggravating problems which are involved in working with the Soviets. The volume of correspondence and detail, however, is enormous, and the resources of Dr. Kenyon of the American Chemical Society have been essential to the progress of the program to date.

There are various asymmetries between US and Soviet scientific institutions which have added to the difficulties of the program. Although the US has managed to send a larger number of people to the Soviet Union, these people have normally been newly graduated Ph. D.'s with limited experience. Furthermore, it has been difficult to find American fellows who are willing to spend periods longer than six months in the Soviet Union, and usually after their return from the Soviet Union, they have accepted different jobs. Soviet fellows, on the other hand, have been fewer in number, but have

stayed for longer periods of time, and generally have been older, more experienced people. The quality of these people has been excellent, and their contributions to the Joint Program substantial. Furthermore, they tend to return to their home institutes, and thereby contribute what they learn in the US to the continuity of their own research programs.

There has been continuing concern that through this program the Soviets may be gaining access to proprietary US industrial catalyst technology. There appears to be little risk of this occurring directly through the projects supported under this program, since the focus of the research has been in fundamental areas which are normally published in the open literature. However, through this program the Soviet scientists have been able to make personal contacts with industrial research workers through symposia sponsored under the program, and they have also visited numerous industrial laboratories. Industrial techniques in this field have been traditionally highly proprietary and closely held, so that it is likely that US corporations have been extremely careful in what they have shown to Soviet visitors. I have not attempted to monitor or control through this program the contacts of the Soviets with industrial companies, or the possible negotiation or sale of catalytic plants or processes to the Soviets.

Maintaining a quid pro quo has also been a source of continuing concern. The Soviets have delivered reasonably well on the projects that were agreed to, although not fully. Problems areas exist im Project I where neither Professor Vol'pin nor research workers from his laboratory have been cleared for travel to the US, and in Project II where a fellow from the Soviet Union has yet to visit the US. It was agreed at the last joint working group session that if these particular problems were not remedied

by 1 July 1976, that consideration would be given to eliminating these projects from the program.

Conclusions

Progress under this program has exceeded my initial modest expectations. Being able to work productively with the Soviets already represents a substantial achievement. The program has clearly provided important personal contacts with the Soviet scientific community, and a valuable window into the organization and management of the Soviet research system. It has been possible to achieve some modest scientific contributions of national interest while maintaining a reasonable balance in the flow of information.

Table I

Project Coordinators and Principal Investigators Associated with U.S./U.S.S.R. Program in Chemical Catalysis

Catalysis by Coordination Complexes and Organo-Metallic Compounds

1. Dr. Jack Halpern (Project Coordinator)
Department of Chemistry
The University of Chicago
5747 Ellis Avenue
Chicago, Illinois 60637

Dr. James P. Collman
Department of Chemistry
Stanford University
Stanford, California 94305

Dr. Earl L. Muetterties
Department of Chemistry
Cornell University
Ithaca, New York 14850

Dr. J. E. Bercaw and
Dr. M. Kubota
Division of Chemistry and
Chemical Engineering
California Institute of Technology
Pasadena, California 91109

Dr. A. Ye. Shilov (Project Coordinator)
Institute of Chemical Physics
U.S.S.R. Academy of Sciences
Chernogolovka, Noginskiy Rayon
Moscow Oblast, U.S.S.R.

Dr. Yu. Yermakov
Institute of Catalysis
Novosibirsk 90, U.S.S.R.

Dr. Mark E. Vol'pin
Institute of Organo-Element Compounds
Vavilov Str. 28
Moscow 312, U.S.S.R.

2. Catalytic Reactor Modeling

Dr. James J. Carberry (Project Coordinator)
Department of Chemical Engineering
University of Notre Dame
Notre Dame, Indiana 46556

Dr. Dan Luss
Department of Chemical Engineering
University of Houston
Houston, Texas 77004

Dr. Leon Lapidus
Department of Chemical Engineering
Princeton University
Princeton, New Jersey 08540

Dr. M. G. Slin'ko (Project Coordinator)
Institute of Catalysis
U.S.S.R. Academy of Sciences
Novosibirsk 90, U.S.S.R.

Dr. A. S. Shmelew
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U.S.S.R. Academy of Sciences
Novosibirsk 90, U.S.S.R.

Dr. G. M. Ostrovskii
Institute of Physical Chemistry, Karpov
Moscow, U.S.S.R.

Dr. Eugene E. Peterson
Department of Chemical Engineering
University of California
Berkeley, California 94720

Dr. Rutherford Aris
Department of Chemical Engineering
University of Minnesota
Minneapolis, Minnesota 55455

Dr. V. I. Timoschenko
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U.S.S.R. Academy of Sciences
Novosibirsk 90, U.S.S.R.

Dr. M. G. Slin'ko
Institute of Catalysis
U.S.S.R. Academy of Sciences
Novosibirsk 90, U.S.S.R.

3. In-depth Study of Selected Catalytic Systems

Dr. W. Keith Hall (Project Coordinator)
Department of Chemistry
University of Wisconsin
Milwaukee, Wisconsin 53201

Dr. George W. Keulks
Department of Chemistry
& Laboratory for Surface Studies
University of Wisconsin
Milwaukee, Wisconsin 53201

Dr. John Turkevich
Department of Chemistry
Princeton University
Princeton, New Jersey 08540

Dr. Michel J. Boudart
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Stanford University
Stanford, California 94305

Dr. W. Henry Weinberg
Department of Chemical Engineering
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Pasadena, California 91109

Dr. John G. Larson
Research Laboratories
General Motors Corporation
Warren, Michigan 48090

Dr. Kh. M. Minachev
Institute of Organic Chemistry
Moscow, U.S.S.R.

Dr. V. B. Kazansky
Deputy Director
Institute of Organic Chemistry
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Dr. Oleg V. Krylov (Project Coordinator)
Institute of Chemical Physics
Vorobyevskoe chaussee, 2b
117334, Moscow, U.S.S.R.

Dr. Yu. Margolis
Institute of Chemical Physics
Moscow, U.S.S.R.

Dr. V. M. Gryaznov
Department of Physical & Colloid Chemistry
Peoples Friendship University
Moscow, U.S.S.R.

Dr. Goldansky
Institute of Chemical Physics
Moscow, U.S.S.R.

Dr. V. I. Savchenko
Institute of Catalysis
Novosibirsk 90, U.S.S.R.

4. Life Support Systems

Dr. Alvin H. Weiss (Project Coordinator)
Department of Chemical Engineering
Worcester Polytechnic Institute
Worcester, Massachusetts 01609

Dr. Michael M. Sakharov (Project Coordinat
Institute of Chemical Physics
Vorobyevskoye chaussee, 25
117334, Moscow, U.S.S.R.

5. Environmental Control

Dr. Vladimir Haensel (Project Coordinator)
Vice President, Science & Technology
Universal Oil Products
Des Plaines, Illinois 60016

Dr. G. K. Boreskov (Project Coordinator)
Director
Institute of Catalysis
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Dr. Joe W. Hightower
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Houston, Texas 77001

Dr. Alexis T. Bell
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Berkeley, California 94720

TABLE II.

CHEMICAL CATALYSIS - RESEARCH FELLOW PROGRAM

April 1974 - December 1975

Man-months

	1. Coordination Complexes		2. Reactor Modeling		3. Selected Systems		4. Life Support Systems		5. Environmental Control	
	US	USSR	US	USSR	US	USSR	US	USSR	US	USSR
74, and 1975 n progress	14 1/2	6	4	-	24	12	6	6	3	-
75, proposed	6	-	-	-	-	18	-	-	-	-
Total	20 1/2 a/	6 b/	4 a/	-	24 a/	30 b/	6 a/	6 b/	3 a/	-

a/ ordination Complexes: MacLaury, Weil, Magnuson, Pretzer
Reactor Modeling: Bruns
Selected Systems: Kibby, Notermann, Taylor, Conner, Miner
Life Support Systems: Partridge
Environmental Control: Van Leirsburgh

b/ Coordination Complexes: Zamaraev
Selected Systems: Shvets, Skliarov, Mastihin, Savchenko, Tapilin
Life Support Systems: Seleznev

TABLE III

PUBLICATIONS

1. E. L. Muetterties, B. Sosinsky and K. Zamaraev, "Cluster Catalysis II. Catalytic Chemistry of $(Fe(CO)_3(C_3H_5))_2$", submitted to J. Amer. Chem. Soc.
2. F. J. Kirsekorn, E. L. Muetterties, L. J. Stuhl, and K. Zamaraev, "ESR and Catalytic Studies of Cobalt (0)", in press.
3. J. Halpern, J. A. Topich and K. Zamaraev, "Electron Paramagnetic Resonance Spectra and Electronic Structures of Organobis(dimethylglyoximato)cobalt(IV) Complexes", prepared for publication.
4. V. L. Kuznetsov, M. R. MacLaury, B. N. Kuznetsov, J. P. Collman, and Y. I. Yermakov, "Hydrogenation Catalysts Containing Phosphine Complexes of Palladium Bound to Silica", prepared for publication.
5. T. Notermann, G. W. Keulks, A. Skliarov, Yu. Maximov, L. Ya. Margolis, and O. V. Krylov, "The Physicochemical Properties of the Bismuth Iron Molybdate System", to be published in J. Catal.
6. T. Notermann, G. W. Keulks, A. Skliarov, A. Frolov, O. Vinogradova, L. Ya. Margolis, and O. V. Krylov, "The Physicochemical Properties and Catalytic Activity of Bismuth Iron Molybdate Catalysts", submitted to Kinet. Katal.
7. A. Skliarov, G. W. Keulks and O. V. Krylov, "The Investigation of the Dehydrocyclization of Heptane by Thermodesorption Methods", in preparation.
8. V. A. Shvets and M. Boudart, "ESR Investigation of the Structure and Properties of $(Rh\text{-}Rh)^+$ Pairs in Rhodium Containing Zeolites", in preparation.

9. V. A. Shvets and M. Boudart, "Ferromagnetic Resonance of Palladium Containing Y-Zeolites", in preparation.

10. N. Yevmenenko, V. A. Seleznev, Ya. B. Ghorochvatskii, M. M. Sakharov, O. V. Krylov, and A. H. Weiss, "Comparison of $Pb(OH)_2$ and $Ca(OH)_2$ pH Effects in Formaldehyde Condensation", in preparation.

11. V. A. Seleznev, T. Chomenko, M. M. Sakharov, and A. H. Weiss, "Inherent pH Limitations in Cation Selective Base Catalysis", in preparation.

12. V. A. Seleznev and A. H. Weiss, "pH Effects in Formaldehyde Condensation", in preparation.